Government of Northwest Territories | Gouvernement des Territoires du Nord-Ouest

Population Estimates of Tuktoyaktuk Peninsula, Cape Bathurst and Bluenose-West Barren-ground Caribou Herds, using Post-calving Photography, July 2012

Tracy M. Davison[1], Heather Sayine-Crawford[1], Kristen Callaghan[2], and Jodie Pongracz[1]

[1] Environment and Natural Resources
Government of the Northwest Territories

[2] Gwich'in Renewable Resources Board
Inuvik, NT

2016

Manuscript Report No. 258

The contents of this paper are the sole responsibility of the authors.

ABSTRACT

A post-calving photographic survey was conducted in 2012 to obtain population estimates for the Tuktoyaktuk, Cape Bathurst, and Bluenose-West caribou herds in the NWT. A total of 105 collars were deployed March 2012 in anticipation of the survey. Photos were taken of the Tuktoyaktuk Peninsula herd on 7 July 2012, Cape Bathurst herd on 6 July 2012 and Bluenose-West herd on 6 July 2012. The resulting Lincoln-Petersen population estimates (with ±95% confidence intervals) of non-calf caribou were 2,192±178 for the Tuktoyaktuk Peninsula herd, 2,427 for the Cape Bathurst herd and 20,465±3,490 for the Bluenose-West herd.

TABLE OF CONTENTS

ABSTRACT iii
LIST OF FIGURES v
LIST OF TABLES vi
INTRODUCTION 1
METHODS 3
Reconnaissance and Collar Deployment 3
Post-calving Survey 4
Population Estimate and Trend 6
Weather Conditions 7
RESULTS 9
Reconnaissance and Collar Deployment 9
Post-calving Survey 11
Population Estimate and Trend: Tuktoyaktuk Peninsula 12
Population Estimate and Trend: Cape Bathurst 13
Population Estimate and Trend: Bluenose-West 16
Weather Conditions 20
DISCUSSION 24
Evaluation of Number of Collars Available 24
Evaluation of Assumptions 24
Weather Conditions 27
CONCLUSION 29
ACKNOWLEDGEMENTS 30
PERSONAL COMMUNICATIONS 31
LITERATURE CITED 32

LIST OF FIGURES

Figure 1. Reconnaissance flight lines and observation locations of barren-ground caribou groups, March 2012.....9

Figure 2. Capture locations of barren-ground caribou, March 2012.....10

Figure 3. Locations of caribou groups observed July 7th on the Tuktoyaktuk Peninsula herd's post-calving range.....12

Figure 4. Locations of caribou groups photographed on July 6th on the Cape Bathurst herd's post-calving range.....14

Figure 5. Locations of caribou groups photographed on July 6th on the Bluenose-West herd's post-calving range.....17

Figure 6. Location of collared Bluenose-West caribou on July 6th (or 5th if data wasn't available for 6th) and the normal Bluenose-West core summer range (1 July - 22 August) from CARMA using collar cow data from 1996-2010 (90% fixed kernels).....28

LIST OF TABLES

Table 1. Sex, number and capture year of active caribou collars during the post-calving photo survey of the Tuktoyaktuk Peninsula, Cape Bathurst and Bluenose-West herds, July 2012.....11

Table 2. Non-calf caribou counted on Tuktoyaktuk Herd photographs, 7 July, 2012.....13

Table 3. Non-calf caribou counted on Cape Bathurst herd photographs, 6 July, 2012.....15

Table 4. Population estimates for the Cape Bathurst herd, 1986-2012.....16

Table 5. Non-calf caribou counted on Bluenose-West herd photographs 6 July, 2012.....19

Table 6. Population estimates for the Bluenose-West herd, 1986-2012.....20

Table 7. Weather at Tuktoyaktuk CARS station, July 2012.....21

Table 8. Weather at Tuktut Nogait National Park weather station, July 2012.....22

Table 9. Population estimates for the Tuktoyaktuk Peninsula herd, 2006-2012.....26

INTRODUCTION

The first photo surveys of barren-ground caribou post-calving aggregations within the range of the Cape Bathurst and Bluenose-West herds were accomplished in 1986 and 1987 by McLean and Russell (1992). However, this survey was of the 'Bluenose' herd, which included barren-ground caribou east of the Mackenzie River to Kugluktuk (Coppermine), and south from the Arctic Coast to Great Bear Lake (McLean and Russell 1992, Nagy et al. 1999). A review of historic survey data and the results of telemetry surveys, which incorporated data from a satellite tracking program started in 1996, indicated that there were three distinct herds using three calving grounds in the historical 'Bluenose' range (Nagy et al. 1999, Nagy 2009, Zittlau et al. 2003). From west to east, these herds are now referred to as the Cape Bathurst (CB), Bluenose-West (BNW) and Bluenose-East (BNE) herds. Seasonal ranges for the three herds were determined using satellite data of collared cows from March 1996 to May 2004 (Nagy et al. 2005). Nagy (2009) reanalyzed caribou surveys from 1986, 1987, 1992 and 2000 using the identified ranges of the three herds.

The Tuktoyaktuk Peninsula (TP) herd was first identified to the Department of Environment and Natural Resources (ENR) during community consultations (ENR 2005). Community members in Tuktoyaktuk believe that caribou returned to the peninsula after the domesticated reindeer herd was removed from TP in 2001 (Nasogaluak, personal communication). It was first surveyed in September 2005 (ENR, internal report) and the first population photo survey was conducted in July 2006 (Nagy and Johnson 2006). It is currently being managed as a separate herd by the Wildlife Management Advisory Council (NWT) [WMAC (NWT)] and ENR. The proportion of the herd that is reindeer or caribou-reindeer hybrids is unknown.

Post-calving photo survey results in 2005 and 2006 showed a significant decline in the CB and BNW herds since they were surveyed in 2000 (Nagy and Johnson 2006). Management

actions were taken by the WMAC (NWT) and the Gwich'in and Sahtú Renewable Resources Boards. Another population survey was conducted in 2009, with results showing the estimated population size of the CB and BNW herds stabilizing between 2006 and 2009. A contributing factor to the stabilization of the CB and BNW herds is likely the management actions implemented by the co-management boards. The TP herd population declined slightly between 2006 and 2009.

The current survey interval for post-calving photo surveys to obtain population estimates is three years. This report presents the results of the photo survey of the TP, CB and BNW herds during July 2012.

METHODS

Reconnaissance and Collar Deployment

In March 2012, reconnaissance flights were flown to determine the late winter distribution of barren-ground caribou in order to facilitate appropriate distribution of collar deployment throughout the herds. Flight lines were planned based on historical seasonal range (Nagy et al. 2005), reports from local harvesters traveling on the land and current collared caribou locations.

Flights were conducted using two Cessna 206 fixed-wing aircraft (North-Wright Airways Ltd., Norman Wells, NWT). All locations of observed caribou were recorded using a handheld Garmin GPS receiver. Flights were flown at an approximate survey altitude of 300 m AGL and average speed of 200 km/hr. Flight lines were spaced approximately 20 km apart (see Figure 1). The number of caribou observed and general composition of the group (cow/calves, bulls, mixed) was provided with location co-ordinates to the capture crew.

Captures were planned based on caribou locations obtained from the reconnaissance flights to ensure collars were deployed throughout the occupied range. Capture crews consisted of a helicopter pilot, a net-gunner and an animal handler. Captures were conducted using an A-Star helicopter (Great Slave Helicopters, Inuvik, NWT) with a sliding door on the same side as the pilot for net gunning.

Captures were conducted using standard operating procedures as approved by the NWT Animal Care Committee (Wildlife Care Committee 2011). Captures were conducted between temperatures of -5°C to -30°C with a pursuit time of less than two minutes. Caribou were captured with a net gun and immobilized with leg hobbles. Blindfolds were used to help calm the animals. Each animal was initially examined to assess its condition and checked for any capture-related injuries. Samples collected from each animal included: approximately 30 ml of blood (from the femoral vein in the foreleg), approximately 50 g of

feces (either from the ground after defecation, or the rectum), and a sample of hair (with roots). Both eyes were checked for *Besnoitia*, and body measurements were taken (total body length, hind foot length, and neck circumference).

We deployed satellite (SAT) collars manufactured by Telonics (Telonics, Inc., Mesa, AZ) and global positioning satellite (GPS) collars manufactured by Lotek Iridium (Lotek Wireless Inc., Newmarket, ON). All cow caribou were fitted with collars such that collars were snug around the neck but allowing for an open-palmed hand to be moved freely between the neck and the collar material. As the necks of bull caribou expand during the rut, collars were affixed loosely on bulls; more space than a clenched fist was available between the neck and the collar material.

All GPS collars were programmed to obtain locations every eight hours (three locations a day). In addition, Lotek Iridium collars (N=10) that were deployed in the area of the Inuvik-Tuktoyaktuk Highway (ITH) (currently under construction) were programmed with a geo-fence that would initiate increased data collection (one hour intervals) when in the ITH regional study area (15 km buffer around the road right of way) to monitor possible effects of construction on caribou movements. SAT collars were programmed to transmit daily locations between May 25th and July 15th and locations every five or seven days during the rest of the year. All collars were also equipped with a VHF transmitter programmed to transmit for 16 hours per day started at 1500 UTC (9:00 local time) during the calving and post calving periods. Each collar was equipped with an automatic release (Telonics CR-2A) set to drop-off August 1st, 2015.

We considered collar number recommendations made by Rettie (2008) and used targets of 60 collars for the BNW, 30 for the CB and 30 for the TP herds.

Post-calving Survey

Flights were flown in early July based on GPS/SAT collar locations. All GPS and SAT collars deployed between 2009 (programed release date of 1 August 2012) and 2012 that were considered active were located to ensure that the VHF was functioning. All collars with a

malfunctioning GPS/SAT component were also scanned for to determine if the VHF component was functioning. Located collars with verified VHF functioning were compiled into a list for the post-calving photo survey.

The herds were monitored remotely using locations from GPS and SAT collars and periodic flights. The survey aircraft for the TP and CB herds was a Cessna 206/207. The survey aircraft for the BNW herd was a Helio-Courier. Once weather and flying conditions were favourable and caribou formed large aggregations, collared caribou were located and high quality digital photos taken. Photos were taken from the fixed-wing aircraft using a Nikon D2x or Nikon D3x digital camera. The photographer was seated behind the pilot in the Helio-Courier and photographs were taken through an opening in the window. In the Cessna 206/207 the photographer sat in the co-pilot seat and opened the window to take photographs. The collar frequencies, photo frame numbers and GPS waypoint for each aggregation were recorded. Each aggregation was assigned a group number. The cameras were connected to a GPS receiver using a Nikon MC-35 GPS adapter cord so that a latitude and longitude were also recorded with the photographs. If the aggregation could not be captured in one photo, a series of overlapping photos were taken in one pass, to ensure minimal movement of caribou between frames.

The best photo (or best series of overlapping photos) for each group was selected. Digital photos were loaded into OziExplorer GPS Mapping Software (Version 3.95.4m, D&L Software Pty Ltd.) to create a photomap of each image. For large caribou groups covered by more than one photo, overlapping images were loaded side-by side on two computer screens and track lines were created in OziExplorer to delineate overlapping areas on images. All adult caribou were counted on the photographs, and recounted independently by another counter, to test for counting error.

The percent of counted animals that were a result of incidental observations were calculated by dividing the number of caribou associated with a group that had no radio collared caribou by the total number of caribou counted and multiplying by 100.

Population Estimate and Trend

Population estimate was calculated using the Lincoln-Peterson method, with the following equation:

$$N = \left(\frac{(M+1)(C+1)}{(R+1)}\right) - 1$$

where N = estimate of population size during the survey; M = total number of caribou with active radio collars present in the herd; C = number of caribou in all aggregations observed during the survey; R = number of radio collared caribou observed in these aggregations during the survey.

The 95% confidence interval (CI) for the estimate can then be calculated as 95% CI= 1.96 $Var(N)^{0.5}$, where:

$$Var(N) = \frac{\left((M+1)(C+1)(M-R)(C-R)\right)}{(R+1)^2(R+2)}$$

A Lincoln-Petersen estimator of relative abundance (K) was used for each herd to determine if the population estimates of caribou in 2009 and 2012 were significantly different (Williams et al. 2002). It was assumed that capture probabilities were different between 2009 and 2012. K and variance of K [Var(K)] was estimated for each herd as follows (Williams et al. 2002):

$$K = \frac{\left[\left(\frac{(M_b+1)(C_b+1)}{(R_b+1)}\right) - 1\right]}{\frac{M_a C_a}{R_a}}$$

$$Var(K) = \left(\frac{R_a M_b C_b}{R_b^3 M_a^3 C_a^3}\right)\left[\left((C_b - R_b)(M_b - R_b)(R_a M_a C_a)\right) + \left((C_a - R_a)(M_a - R_a)(R_b M_b C_b)\right)\right]$$

where the same inputs (M, C and R) are used as for the population estimation equation (N). The subscripts a and b refer to data from the time period 2009 and 2012 of the comparisons, respectively.

The 95% CI of K was calculated as 1.96 $\text{Var}(K)^{0.5}$(Williams et al. 2002). If K was <1 and the 95% CI did not include 1, the population estimate for 2012 was significantly lower than that for 2009. If K was >1 and the 95% CI did not include 1, the population estimate for 2012 was significantly higher than that for 2009. If the 95% CI around K included 1, the population estimates for 2009 and 2012 were not significantly different.

There are four assumptions related to this method of population estimation (Russell et al. 1996):

Assumption 1: The population is closed.

Assumption 2: Caribou are aggregated in groups that contain at least one radio collared caribou and thus can be located.

Assumption 3: Radio collared animals are randomly distributed throughout the herd.

Assumption 4: No significant movement of individual caribou among photographed groups used in the estimate occurred during the photo survey.

Using this method to calculate population size, post-calving photo surveys likely underestimate herd size (Rivest et al. 1998); however, this method is consistent with historic surveys (Nagy 2009, Nagy and Johnson 2006) and indicates population trend.

Weather Conditions

The post-calving survey method relies on the caribou forming aggregations in response to insect harassment (Rivest et al. 1998). Weather conditions that are associated with increased insect harassment and caribou aggregation are warmer days with calmer winds (Dau 1986, Walsh et al. 1992, Hagemoen and Reimers 2002). Weather data, including air temperature in degrees Celsius and wind speed in km/hr, were obtained from the

community aerodrome radio station (CARS) weather station at Tuktoyaktuk, and the Parks Canada weather station in Tuktut Nogait National Park.

RESULTS

Reconnaissance and Collar Deployment

Between March 1st and 5th, reconnaissance flights were conducted using two planes, one covering the Inuvialuit Settlement Region and the other the Sahtú Settlement Region (Figure 1). Weather conditions were generally sunny with calm winds and good visibility, therefore suitable for aerial observation of wildlife.

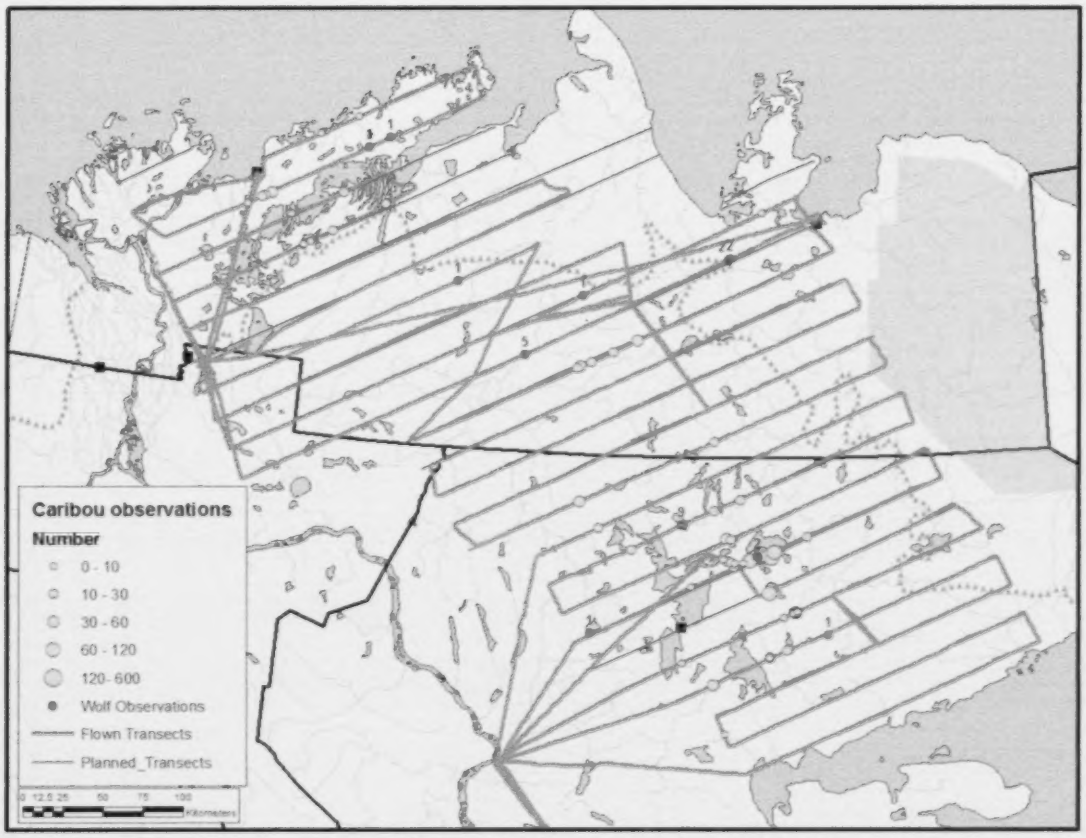

Figure 1. Reconnaissance flight lines and observation locations of barren-ground caribou groups, March 2012.

Between March 3rd and 28th, 105 caribou were captured by aerial net gunning (Figure 2) and equipped with collars (58 Telonics GPS, 37 Telonics SAT and 10 Lotek Iridium). Of the total, 59 deployments were conducted over the wintering range of the BNW herd and 46

over CB and TP herds, which have overlapping winter ranges. No captures were conducted within 50 km of the community of Colville Lake due to concerns expressed by the community.

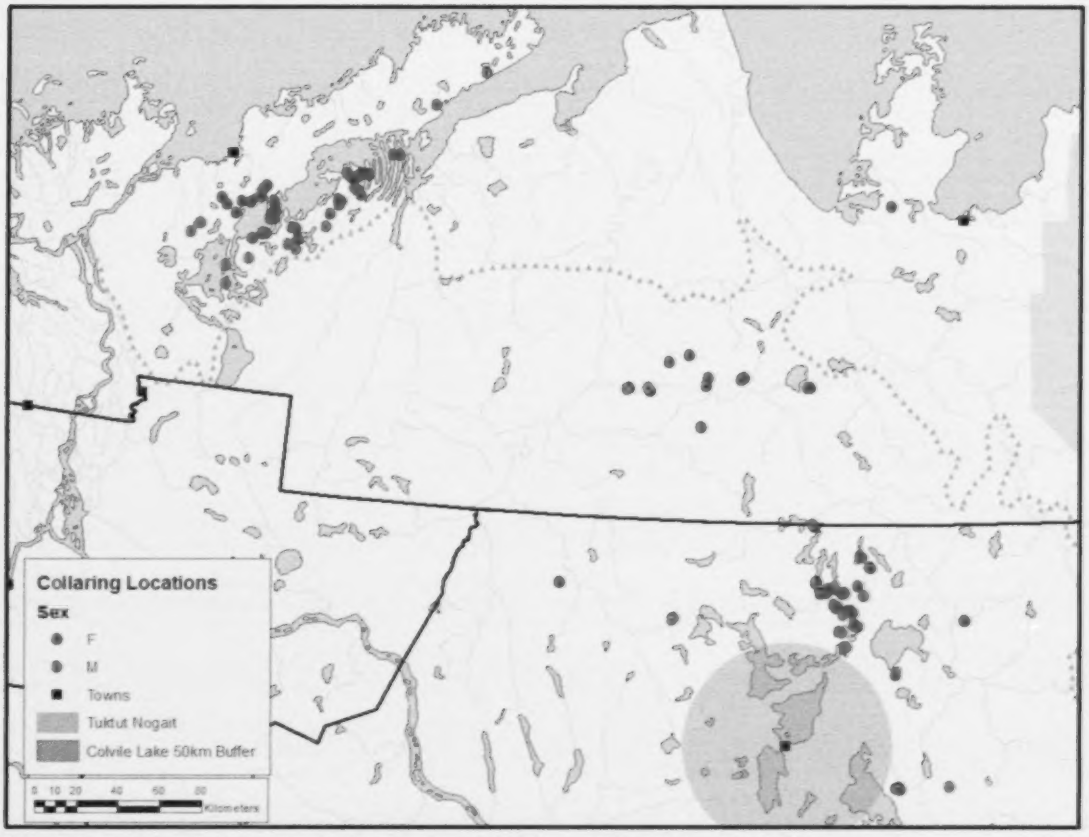

Figure 2. Capture locations of barren-ground caribou, March 2012.

There were an additional 14 collars that were targeted to be deployed on TP and CB herds. These were not deployed due to weather delays and collaring crew complications (including the injury of a crew member during capture).

There were two mortalities of caribou during collar deployment. One male in the CB range had to be shot after an injury from the net gun weight. One female on the BNW range had to be shot because of a broken leg inflicted during the capture procedure. Both mortalities

were field dressed, and meat was brought back to be distributed as per the standard operating procedures. One female on the BNW range was also captured and released without affixing a collar due to her poor body condition and visible sores.

Average pursuit time for caribou capture was just under one minute. Average handling time, from when the caribou was first captured in the net to release, was 15 minutes and ranged from nine minutes to 32 minutes.

Post-calving Survey

Surveys to verify the number and frequency of collars with functioning VHF components commenced June 30th. There were 23 collars available in the TP herd, 24 collars in the CB herd and 55 collars in the BNW herd (Table 1). Ninety-two of 105 collars deployed in March 2012 and ten collars deployed in 2009 were available for the photo survey. Of the collars that were deployed in March 2012 that were not available; three were confirmed mortalities (one was a mortality during the survey where a bear was observed on the carcass, other two were unknown causes), two were malfunctions and the other eight were stationary due to unknown reasons.

Table 1. Sex, number and capture year of active caribou collars during the post-calving photo survey of the Tuktoyaktuk Peninsula (TP), Cape Bathurst (CB) and Bluenose-West (BNW) herds, July 2012.

	Female		Female Total	Male		Male Total	Grand Total
Year Collared	2009	2012		2009	2012		
CB	4	16	20	0	4	4	24
TP	1	16	17	1	5	6	23
BNW	1	39	40	0	15	15	55

Photos were taken of the TP herd on July 7th, CB herd on July 6thand of the BNW herd on July 6th.

Population Estimate and Trend: Tuktoyaktuk Peninsula

Twenty-two of 23 collars available on the TP herd were photographed on July 7th (Figure 3). A total of 2,101 adult caribou were counted on the photographs (Table 2). The population was estimated to be 2,192±178 (95% CI).

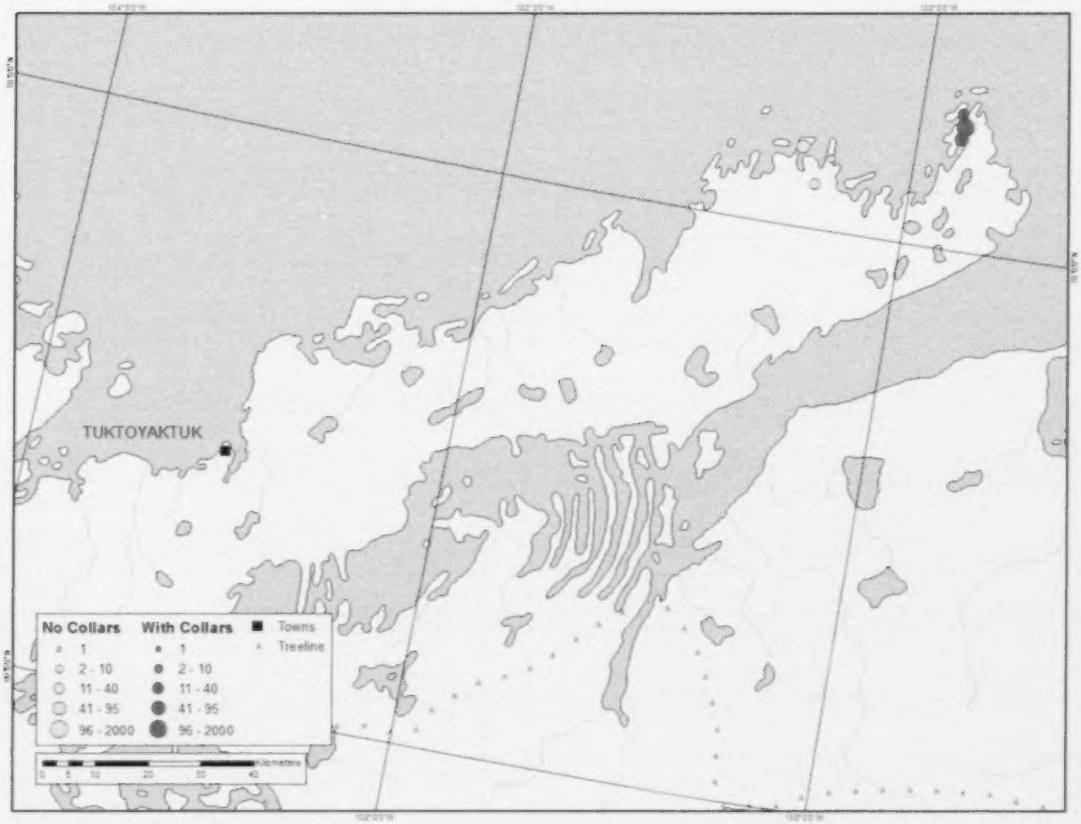

Figure 3. Locations of caribou groups observed July 7th on the Tuktoyaktuk Peninsula herd's post-calving range.

Table 2. Non-calf caribou counted on Tuktoyaktuk Peninsula herd photographs, 7 July, 2012.

Group	Number of Collars	Number of Caribou
1	0	3
2	2	95
3	0	1
4	19	1,871
5	0	72
6	0	38
7	1	21
Total	22	2,101

The number of incidental caribou observed was 5.4% of caribou counted for TP, which was lower than the 16.3% in 2009 (Davison et al. 2014).

Photos were independently counted and an average of the two counts was used for calculations. Difference between counts was 4%.

The 2012 population estimate was compared to the 2009 results [2,753±276 (95% CI) (Davison et al. 2014)]. *K* was calculated to be 0.79 with a 95% CI from 0.68-0.90. Therefore, the 2012 population estimate was significantly lower than the 2009 estimate.

Population Estimate and Trend: Cape Bathurst

All 24 collars available on the CB herd were photographed on July 6th (Figure 4). The average total number of adult caribou counted on the photographs was 2,427 (Table 3). The population estimate is the same as the total count with no CI counted because all of the collars were photographed.

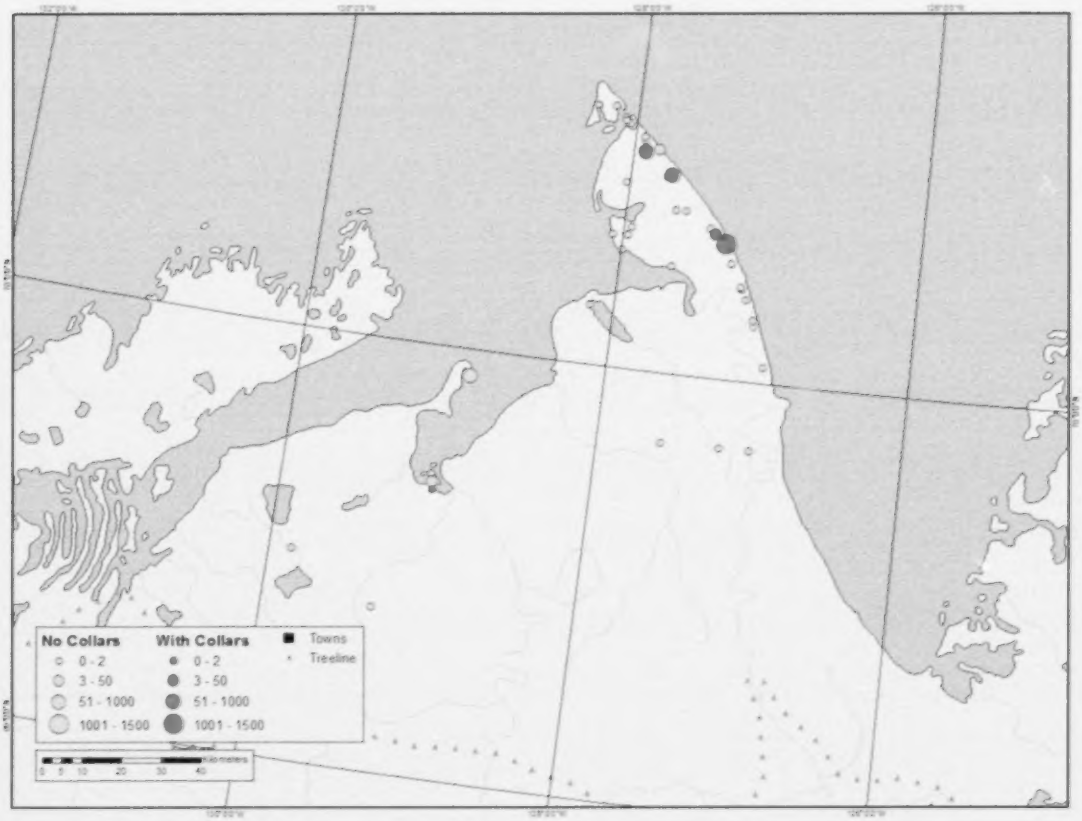

Figure 4. Locations of caribou groups photographed on July 6th on the Cape Bathurst herd's post-calving range.

Table 3. Non-calf caribou counted on Cape Bathurst herd photographs, 6 July, 2012.

Group	Number of Collars	Number of Caribou
1	1	2
2	0	1
3	0	3
4	0	140
5	0	1
6	0	1
7	0	1
8	0	1
9	0	1
10	6	523
11	0	15
12	5	265
13	0	1
14	0	1
15	0	1
16	0	1
17	0	2
18	0	1
19	0	1
20	0	1
21	0	1
22	1	47
23	11	1,410
24	0	1
25	0	1
26	0	1
27	0	1
28	0	1
29	0	1
Total	24	2,427

The number of incidental caribou observed was 7.4% of caribou counted for CB. Despite the lower number of collars used, these values are similar to incidental sighting rates in the past; 7.2% in 2009 (Davison et al. 2014).

Photos were independently counted and an average of the two counts was used for calculations. Difference between counts was 1%.

The 2012 population estimate was compared to the 2009 results [1,934±350 (95% CI) (Davison et al. 2014)] (Table 4). *K* was calculated to be 1.24 with a 95% CI from 1.001-1.479. Therefore, the 2012 population estimate was significantly higher than the 2009 estimate.

Table 4. Population estimates for the Cape Bathurst herd, 1986-2012.

Year	*M*	*C*	*R*	*N*	95% CI	Lower 95% CI	Upper 95% CI
1986	3	13,476	3	**13,476**	**0**	13,476	13,476
1987	6	10,728	5	**12,516**	**3,504**	9,012	16,020
1992	6	16,524	5	**19,278**	**5,397**	13,881	24,675
2000	17	9,857	15	**11,089**	**1,756**	9,333	12,845
2005	32	2,213	29	**2,434**	**257**	2,178	2,691
2006	33	1,714	31	**1,821**	**149**	1,672	1,971
2009	28	1,534	22	**1,934**	**350**	1,584	2,284
2012	24	2,427	24	**2,427**	**n/a**	**n/a**	**n/a**

N = estimate of population size during the census.
M = number of radio collared caribou present in the herd (including all collars known to be active during the survey).
C = number of caribou in all aggregations observed during the survey.
R = number of radio collared caribou observed in these aggregations during the survey.

Population Estimate and Trend: Bluenose-West

The estimate for the BNW herd was confounded by poor conditions for the survey with many caribou in eastern groups not aggregated and therefore not photographed and counted. Only 38 of the 55 available collars on the BNW were photographed July 6th (Figure 5). The average total number of adult caribou counted on the photographs was 14,252 (Table 5). The population was therefore estimated to be 20,465±3,490 (95% CI).

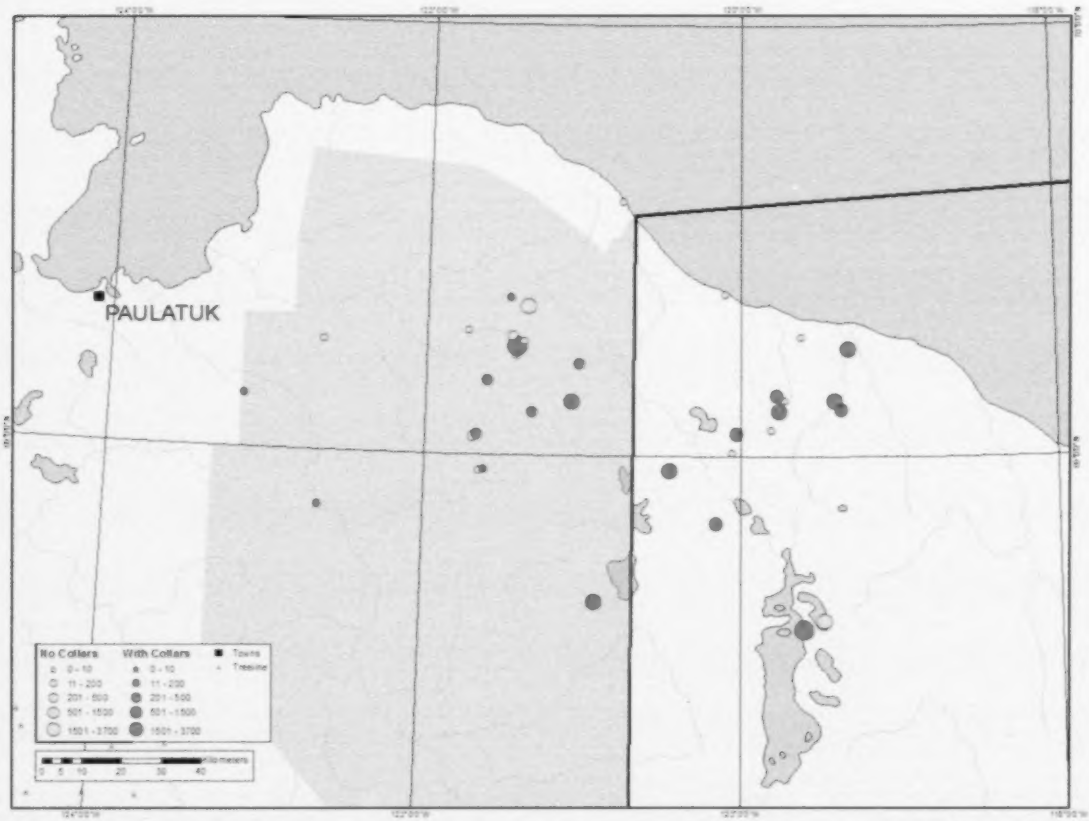

Figure 5. Locations of caribou groups photographed on July 6th on the Bluenose-West herd's post-calving range.

The incidental caribou observed compared to groups that were photographed was 9.7% for BNW, however this doesn't include the caribou (including collared caribou) in the eastern side of the range that were not aggregated sufficiently for photography therefore this statistic is not very meaningful. In 2009 incidental sightings were 8.9% of caribou counted.

Photos were independently counted and an average of the two counts was used for calculations. Difference between counts was 7%.

BNW groups 18 and 23 (Table 5) each had one BNE collared caribou along with one BNW collared caribou. Therefore, the number of caribou counted within these groups were split 50-50 between BNW and BNE so only half of each group was considered BNW in the analyses. This is consistent with protocols used in past surveys (Davison et al 2014, Patterson et al 2004).

Table 5. Non-calf caribou counted on Bluenose-West herd photographs 6 July, 2012.

Group	Number of Collars	Number of Caribou
1	9	1,949
2	0	2
3	0	24
4	1	183
5	3	596
6	1	117
7	0	101
8	1	174
9	1	1
10	1	129
11	0	1
12	1	448
13	0	559
14	1	1
15	0	1
16	0	3
17	0	1
18	1[1]	1,423
19	3	822
20	1	408
21	1	316
22	1	785
23	1*	211
24	0	1
25	3	547
26	2	350
27	2	3,652
28	0	696
29	2	747
30	1	3
31	1	1
Total	38	14,252

* One BNE collar was also present in this group, but the number of collars and caribou presented is the numbers used to estimate the BNW herd.

The 2012 results were compared to the 2009 results [17,897±1310 (95% CI) (Davison et al. 2014)] (Table 6). *K* was calculated to be 1.14 with a 95% CI from 0.92-1.36. Therefore, the population estimate for 2012 was not significantly different from the 2009 estimate.

Table 6. Population estimates for the Bluenose-West herd, 1986-2012.

Year	*M*	*C*	*R*	*N*	95% CI	Lower 95% CI	Upper 95% CI
1986	35	83,460	33	**88,369**	**6,899**	81,470	95,269
1987	44	104,512	43	**106,887**	**4,655**	102,233	111,542
1992	33	76,008	22	**112,360**	**25,566**	86,794	137,926
2000	47	52,508	32	**76,376**	**14,347**	62,029	90,723
2005	63	17,875	54	**20,800**	**2,040**	18,760	22,840
2006	66	17,781	65	**18,050**	**527**	17,523	18,578
2009	54	16,595	50	**17,897**	**1,310**	16,587	19,207
2012	55	14,252	38	**20,465**	**3,490**	16,975	23,955

N = estimate of population size during the census.
M = number of radio collared caribou present in the herd (including all collars known to be active during the survey).
C = number of caribou in all aggregations observed during the survey.
R = number of radio collared caribou observed in these aggregations during the survey.

Weather Conditions

The post-calving photographic survey depends on weather conditions favorable for insect harassment. Daily weather data at 10:00, 15:00 and 19:00 MST recorded at the Tuktoyaktuk CARS station and the Tuktut Nogait weather station, including temperature and wind are shown in Tables 7 and 8.

Table 7. Weather at Tuktoyaktuk CARS station, July 2012.

	10:00			15:00			19:00		
Date	**Temp. (°C)**	**Wind Direction**	**Wind Speed (km/h)**	**Temp. (°C)**	**Wind Direction**	**Wind Speed (km/h)**	**Temp. (°C)**	**Wind Direction**	**Wind Speed (km/h)**
1-Jul-12	18.9	120	22	21.8	100	13	21.6	40	19
2-Jul-12	15.2	10	22	17.1	10	22	17.9	10	19
3-Jul-12	20.2	90	15	24.1	80	22	21.9	60	28
4-Jul-12	19.8	80	22	24.2	80	20	20.6	290	13
5-Jul-12	21.9	160	15	25.3	140	6	19.5	30	15
6-Jul-12	**21.9**	**130**	**6**	**26.1**	**130**	**2**	**24**	**100**	**19**
7-Jul-12	**19.7**	**70**	**13**	**20.8**	**40**	**20**	**19**	**40**	**24**
8-Jul-12	19.9	70	20	23.3	70	11	17	10	15
9-Jul-12	12.4	30	17	13.6	70	24	13.3	50	24
10-Jul-12	6.7	40	26	9.2	40	32	8.7	40	32
11-Jul-12	14.2	70	26	15.2	40	20	14.8	30	24
12-Jul-12	16.6	150	70	20.8	150	15	22.3	170	13
13-Jul-12	22.1	170	13	25.9	160	17	26.2	130	11
14-Jul-12	20.8	260	17	22.6	280	20	22.7	300	11
15-Jul-12	15.4	330	7	14.2	30	17	14.1	40	24
16-Jul-12	10.2	10	20	10.1	260	19	10	350	15
17-Jul-12	14.6	260	13	16.2	320	7	13.2	10	15
18-Jul-12	11.5	350	20	12	10	20	12.3	340	4
19-Jul-12	14.6	170	6	15.5	350	13	15.7	30	17
20-Jul-12	17.7	170	19	18.9	230	13	16.8	310	20
21-Jul-12	14.3	100	9	16.6	100	11	16.1	70	13
22-Jul-12	10.2	70	15	14.5	310	6	15	140	9

*Grey highlighted dates are dates photographed

Data from Environment Canada (http://climate.weather.gc.ca/data_index_e.html)

Table 8. Weather at Tuktut Nogait National Park weather station, July 2012.

	10:00			15:00			19:00		
Date	Temp. (°C)	Wind Direction	Wind Speed (km/h)	Temp. (°C)	Wind Direction	Wind Speed (km/h)	Temp. (°C)	Wind Direction	Wind Speed (km/h)
1-Jul-12	15.6		39	18.4		33	18.7		37
2-Jul-12	18		28	19.3		28	18.7		28
3-Jul-12	15.7		39	17.4		35	16.9		39
4-Jul-12	17		28	18.6		20	18.6		24
5-Jul-12	16.7		13	20.5		7	21		9
6-Jul-12	19.6		19	19.7		4	20.3		13
7-Jul-12	19.9		11	20.9		11	20.7		15
8-Jul-12	21.4		4	22.5		13	22		13
9-Jul-12	18.5		11	17.5		11	16.5		13
10-Jul-12	11.9		15	14		11	13.6		26
11-Jul-12	8.9		33	11.7		28	11		28
12-Jul-12	11.5		33	14.1		19	14		20
13-Jul-12	14.3		28	17.8		24	18.5		13
14-Jul-12	17.5		9	18.6		9	19		9
15-Jul-12	19.1		7	21		4	21.5		11
16-Jul-12	17.3		13	13.3		15	14.8		17
17-Jul-12	6.2		22	7.1		28	7.5		24
18-Jul-12	10.7		6	14.4		9	11.7		19
19-Jul-12	4.7		11	7.7		15	8.6		15
20-Jul-12[1]				15.6		22	15.4		30
21-Jul-12	13.7		15	13.3		4	12.1		13
22-Jul-12	10.7		7	53.8		24	4.7		19

*Grey highlighted dates are dates photographed
Data from Environment Canada (http://climate.weather.gc.ca/data_index_e.html)
[1] data unavailable at 10:00

Weather conditions were warm in early July, 2012. The maximum temperatures recorded at the Tuktoyaktuk weather station on the 6th and 7th of July were 26.6°C and 21.3°C respectively. These temperatures were warmer in comparison to the 2009 survey temperatures which occurred on July 18th (CB) and July 13th (TP) and were 13.2°C and 17.8°C respectively. The wind speed varied between 6 and 19 km/hr on July 6th and 13-24

km/hr on July 7th at the Tuktoyaktuk weather station. In 2009 the wind speed was 9-19 km/hr on July 13th and 17-19 km/hr on July 18th.

On July 6th, the maximum temperature recorded at the Tuktut Nogait weather station was 21.4°C. In 2009 the BNW herd was photographed on July 12th and July 13th with maximum temperatures of 11.4°C and 18.4°C respectively. The wind speed varied between 4 and 19 km/hr on July 6th at the Tuktut Nogait weather station. In 2009, the wind speed was between 6-17 km/hr on July 12th and 13th.

DISCUSSION

Evaluation of Number of Collars Available

Rettie (2008) used 2006 herd data in simulations to determine the number of collars required to have more than 80% probability of detecting at least 90% of each herd, including 6.4% of observed caribou detected incidentally. These collar numbers were: 81 BNW, 35 CB and 21 TP. These recommendations also allowed some room to have lower sample size of collars on the BNW and CB caribou "without much risk of underestimating herd size" (Rettie 2008). Despite their higher cost, SAT and GPS collars were deployed instead of VHF collars in order to gain the best quality data possible from collared animals. We deployed less than the ideal collar number for the BW and CB herds due to balancing the numbers of collars needed with concerns about impacts of collars on caribou expressed by communities and financial limitations. We used targets of 60 collars for BNW, 30 CB and 30 TP. This is close to a second set of recommendations made by Rettie (2008) in which he used artificial herd simulations and considered marginal values associated with different numbers of collars to recommend 60 BNW, 30 CB and 30 TP collars. The number of collars in a herd is influenced by the number and size of groups during aggregation in addition to the actual population size (Rettie 2008). We did not reach our target number of collars for the BNW herd due to mortalities and malfunction of some collars. There were 14 collars that were unable to be deployed on the CB and TP herds due to weather and crew difficulties during March of 2012 which meant the target number of 30 collars for each herd was not reached.

Evaluation of Assumptions

Assumption 1: The population is closed.

Over an annual timeframe there is a very low rate of exchange which would violate this assumption; however, at the small time scale of the survey, the likelihood of violation is minimal: The survey is done over a small timeframe; the list of available collars for all

herds was completed on June 30th. All photographs were taken over one or two days approximately a week after determining the available collars for each herd, therefore large scale movements of caribou out of or into the survey area were unlikely. This survey occurs after the calving period but does not include calves in the population estimates. Mortality rates for adults during this one week period would likely be low so any adult mortality that did occur would not significantly affect the estimates.

We consider this assumption sufficiently met for the TP and CB herds. However, there was some mixing of the BNW herd during this period with the BNE herd (two groups included collars from both BNW and BNE herds) therefore this assumption was not fully met for the BNW herd.

Assumption 2: Caribou are aggregated in groups that contain at least one radio collared caribou and thus can be located.

For the TP herd, 19 of the 22 collars photographed were in a single large group of 1,871 adult caribou (Table 2; Group 4). The largest group located without a collar was 72. The percentage of incidental caribou observations for the TP herd in 2012 were the lowest recorded compared to the CB and BNW in 2012 and to surveys in 2009 and in 2006. Incidental group sizes for TP herd were also small in comparison to group sizes across the three herds. The post calving area of the TP herd is a relatively small area which increases the chances of groups without collars being observed. We therefore consider this assumption to have been sufficiently met. However, we recommend that in the future a target number of 30 collars be reached to increase the probability that larger groups have at least one collared caribou.

For the CB herd, the largest group located in which no collars were observed contained 140 caribou (Table 9). The percentage of incidental caribou observed was within range of 2009 and 2006 survey sighting rates. We recommend that in the future the target number of 30 collars be reached to increase the probability of larger groups containing at least one collared caribou.

Table 9. Population estimates for the Tuktoyaktuk Peninsula herd, 2006-2012.

Year	*M*	*C*	*R*	*N*	95% CI	Lower 95% CI	Upper 95% CI
2006	27	3,078	27	**3,078**	**n/a**	**n/a**	**n/a**
2009	27	2,556	25	**2,752**	**276**	2,476	3,028
2012	23	2,101	22	**2,192**	**178**	2,014	2,370

N = estimate of population size during the census.
M = number of radio collared caribou present in the herd (including all collars known to be active during the survey).
C = number of caribou in all aggregations observed during the survey.
R = number of radio collared caribou observed in these aggregations during the survey.

The estimate for the BNW herd was confounded by poor conditions for the survey with many caribou in eastern groups not aggregated, and therefore, not photographed and counted. Therefore, for the BNW herd this assumption was not met. The largest group photographed without any collars was group 28 (696 caribou), which was near group 27 (3,652 caribou) which had two collared caribou. Under ideal conditions it is likely these groups would have aggregated and contained a collar. We recommend that in the future researchers try to ensure the target number of 60 collars for this herd is reached. As ideal conditions may not always be present, more collars would increase the probability that larger groups have a collared individual and decrease the probability of missing groups.

Assumption 3: Radio collared animals are randomly distributed throughout the herd.

Collars were distributed over the entire occupied late winter (March) distribution (see Figures 1, 2). In addition, the time elapsed between collaring and post-calving allowed for

some random mixing of the migrating caribou, thus we consider this assumption to have been adequately met.

Assumption 4: No significant movement of individual caribou, among photographed groups used in the estimate, occurred during the photo-survey.

We consider this assumption to have been adequately met because all collar frequencies were continually monitored to ensure that groups were not counted twice; furthermore, photographs were taken within one day for all three herds (reducing the opportunity for movement between groups).

Weather Conditions

The caribou that were found on the BNW range were found further north and east than where they usually are in July (Figure 6). This is most likely due to the high temperatures; the BNW caribou may have shifted their distribution to get relief from the heat.

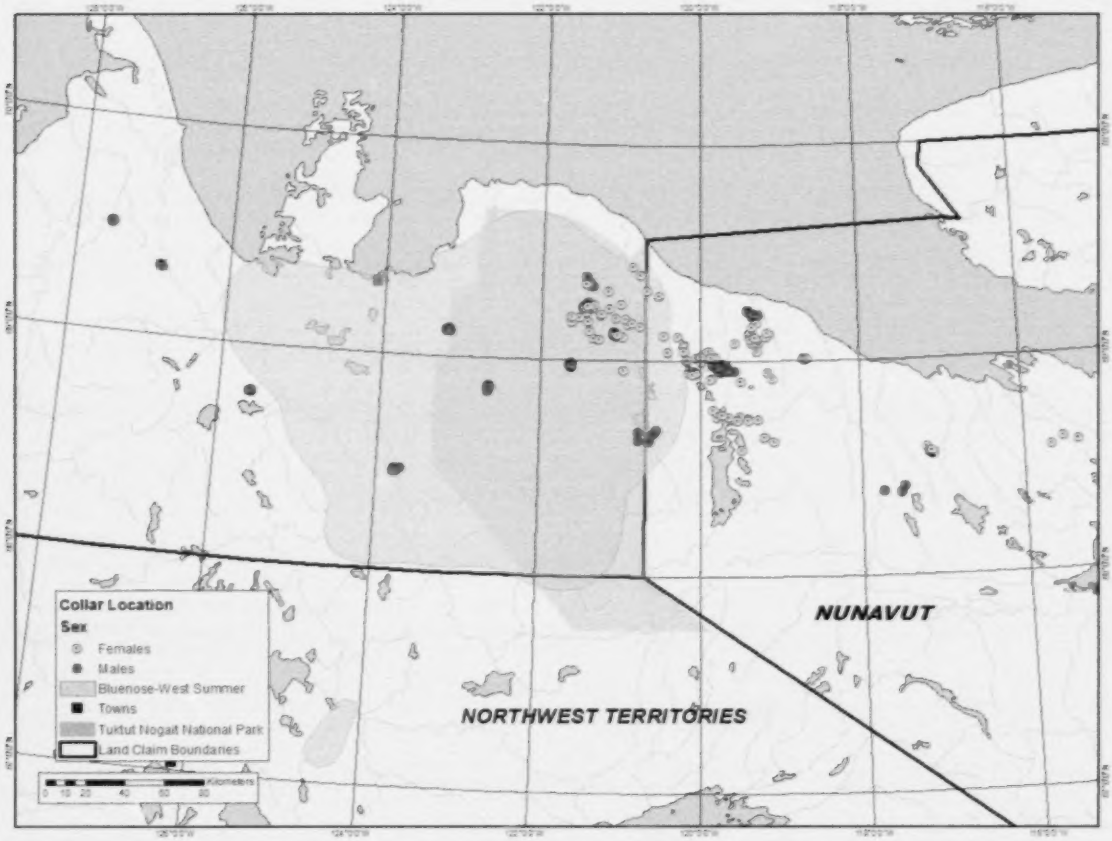

Figure 6. Location of collared Bluenose-West caribou on July 6th (or 5th if data wasn't available for 6th) and the normal Bluenose-West core summer range (1 July - 22 August) from CARMA using collar cow data from 1996-2010 (90% fixed kernels).

CONCLUSION

The estimate for the CB herd was identical to the number of caribou counted. It is likely that the actual number of CB caribou is higher than this because there is no estimate above the minimum count using the Lincoln-Peterson method, although we do not believe a significant number of caribou were missed. Different statistical methods (Rivest 1998) are currently being evaluated.

The relatively low number of collars photographed on the BNW range due to poor aggregation of some groups resulted in a wide confidence interval. For this reason the 2012 estimate was not significantly different from the 2009 population estimate. However the point estimate from the 2012 survey was higher than the point estimate from the 2009 survey. The results were sufficient to show that the herd appears to be at least stable. However, because of the issues with the BNW herd not meeting assumptions 1 and 2 this estimate should be taken with caution.

ACKNOWLEDGEMENTS

This study was jointly funded by Inuvialuit Wildlife Studies Funds, Parks Canada (Western Arctic Field Unit), Gwich'in Renewable Resources Board Wildlife Studies Fund, and the Government of the Northwest Territories' Department of Environment and Natural Resources (ENR).

The capture crew appreciated the safe piloting of the capture aircraft by Kevin Mitchener (Canadian Helicopters), Benedikt Segura and Chuck Grandy (Great Slave Helicopters). Kevin Allen and Ian Ellsworth (ENR, Inuvik and North Slave) were net-gunners for captures.

Jonah Nakimayak (Paulatuk HTC), Jerry Rogers (Inuvik HTC), Allen Firth (Inuvik RRC), Richard Cockney (ENR, Tuktoyaktuk) Ernie Dillon (Inuvik, HTC), Michel Lafferty (Fort Good Hope) and Shane McNeely (Fort Good Hope), Christine Menno (ENR, Inuvik), and Jan Adamczewski (ENR, Yellowknife) assisted with reconnaissance flights. Dean Austin (Wolverine Air) and Travis Wright (North-Wright Airways) piloted the reconnaissance flight aircrafts.

Marsha Branigan (ENR, Inuvik) and Judy Williams (ENR, Yellowknife) assisted with the logistics and purchasing of collars. Christine Menno (ENR, Inuvik) provided lab-related assistance. Phil Spencer (ENR, Norman Wells) provided GIS support. Stephanie Behrens (ENR, Sahtú) assisted with counting photos.

Billy and Eileen Jacobson hosted crews at Rendezvous Lake.

Perry Linton and Kyle Newhook (North Wright Airways Ltd., Norman Wells) piloted the fixed-winged aircrafts for the photo-surveys.

PERSONAL COMMUNICATIONS

Nasogaluak, D. Elder. Tuktoyaktuk Hunters and Trappers Meeting, 12 September 2006.

LITERATURE CITED

Dau, J.R. 1986. Distribution and behaviour of barren-ground caribou in relation to weather and parasitic insects. MS. Thesis, University Of Alaska. Fairbanks, AK. 149pp.

Davison, T., K. Callaghan, R. Popko and B. Milakovic. 2014. Population estimates of Tuktoyaktuk Peninsula, Cape Bathurst and Bluenose-West Barren-ground Caribou Herds using Post-Calving photography, July 2009. Department of Environment and Natural Resources, Government of the Northwest Territories. Manuscript Report No. 239. 31pp.

ENR. 2005. Caribou on the Tuktoyaktuk Peninsula. Internal Report. ENR. September 2005.

Hagemoen, R.I.M and E. Reimers. 2002. Reindeer summer activity pattern in relation to weather and insect harassment. Journal of Animal Ecology 71:883-892.

McLean, B.D. and H.J. Russell. 1992. Photocensus of the Bluenose caribou herd in July 1986 and 1987. Department of Renewable Resources, Government of the Northwest Territories. File Report No. 108. 32pp.

Nagy, J.A. 2009. Evidence that the Cape Bathurst, Bluenose-West and Bluenose-East Calving Grounds are not Theoretical and Justification for Division of the "Bluenose" Herd into the Cape Bathurst, Bluenose-West and Bluenose-East Herds. Department of Environment and Natural Resources, Government of the Northwest Territories. Manuscript Report No. 194. 69pp.

Nagy, J.A., M. Branigan, A. Veitch, R. Popko and J. Nishi. 1999. Co-management plan for the Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou herds and work plans for years 1999/2000 to 2003/2004. Department of Resources, Wildlife, and Economic Development, Government of the Northwest Territories. Manuscript Report No.167. 41pp.

Nagy, J.A., W.H. Wright, T.M. Slack and A.M. Veitch. 2005. Seasonal ranges of the Cape Bathurst, Bluenose-West, and Bluenose-East barren-ground caribou herds. Department of Environment and Natural Resources, Government of the Northwest Territories. Manuscript Report No. 167. 44pp.

Nagy J.A. and D. Johnson. 2006. Estimates Of The Number Of Barren-ground Caribou in the Cape Bathurst and Bluenose-West Herds and Reindeer/Caribou on the Upper Tuktoyaktuk Peninsula Derived using Post Calving Photography, July 2006. Department of Environment and Natural Resources, Government of the Northwest Territories, Northwest Territories. Manuscript Report No.171. 66pp.

Patterson, B.R., G.T. Olsen and D.O. Jolly. 2004. Population estimate for the Bluenose-East caribou herd using post-calving photography. Arctic 57(1): 47-58.

Rettie, W.J. *in prep.* Determining optimal radio-collar sample sizes for monitoring barren-ground caribou populations. Report prepared for Government of the Northwest Territories, 18 July, 2008.

Rivest, L-P., S. Couturier and H. Crépeau. 1998. Statistical methods for estimating caribou abundance using post-calving aggregations detected by radio telemetry. Biometrics 54: 865-876.

Russell, H.J., S. Couturier, L.G. Sopuck and K. Ovaska. 1996.Post-calving photo-census of the Rivière George caribou herd in July 1993. Rangifer Special Issue [9] 319-330.

Walsh, N.E., S.G. Fancy, T.R. McCabe, and L.F. Pank. 1992. Habitat use by the Porcupine caribou herd during predicted insect harassment. Journal of Wildlife Management 56: 465-473.

Wildlife Care Committee. 2011. Standard Operating Procedure (SOP) for Capture, Handling and Release of Caribou. Version 2.
Online: www.enr.gov.nt.ca/sites/default/files/guidelines/nwtwcc_sop_caribou.pdf

Williams, B.K., J.D. Nichols and M.J. Conroy. 2002.Analysis and management of animal populations. Academic Press. San Diego, CA. 817pp.

Zittlau, K., J.A. Nagy, N.C. Larter and C. Strobeck. 2003. Genetic relatedness of caribou herds in Northwest Territories, western Nunavut and the Yukon Territory. Abstract, Rangifer Special Issue No. 14: 328.